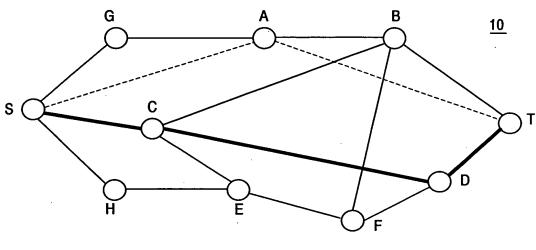## Fig. 1
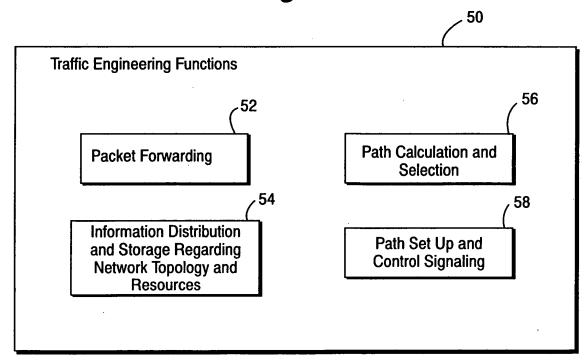

------- IGP Shortest Path From S to T

——— Traffic Engineering Path From S to T

Fig. 4

Traffic Engineering Functions

Packet Forwarding

Information Distribution and Storage Regarding Network Topology and Resources

Path Calculation and Selection

Path Set Up and Control Signaling

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Fig. 2

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Path Calculation

Receive request for a path from node S
to node T through network for a connection   14

Determine a priority level and resources
needed to support connection   16

Review traffic engineering database that
includes priority level information
of links in existing paths   18

Calculate paths taking into account
priority levels of established paths, (e.g., which
and/or how many priority level(s) are pre-empted)   20

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Fig. 3

Minimize Pre-emption
Path Calculation 30

Receive request for a path from node S
to node T through network for connection 32

Determine set-up priority level and
bandwidth (BW) needed to support connection 34

Determine BW reservations for network links.
Note for each link the maximum BW and available
BW at each priority level 36

Eliminate links with insufficient resources,
i.e., "prune" links, for requested connection 38

Optionally restrict remaining paths to a least cost
paths, e.g., fewest number of "hops" 40

For these remaining paths, determine (1) which
lower priority levels will be affected by the set up of
the new path (e.g., on which priority level will LSPs
be pre-empted), (2) how much reserved BW will be
pre-empted at each priority level, and (3) how much
free bandwidth is available at the lowest priority level. 42

Select path that pre-empts the lowest priority level,
the least amount of reserved BW, and/or most
amount of unreserved BW at the lowest priority level 44

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Fig. 5 ___MPLS Forwarding Table___

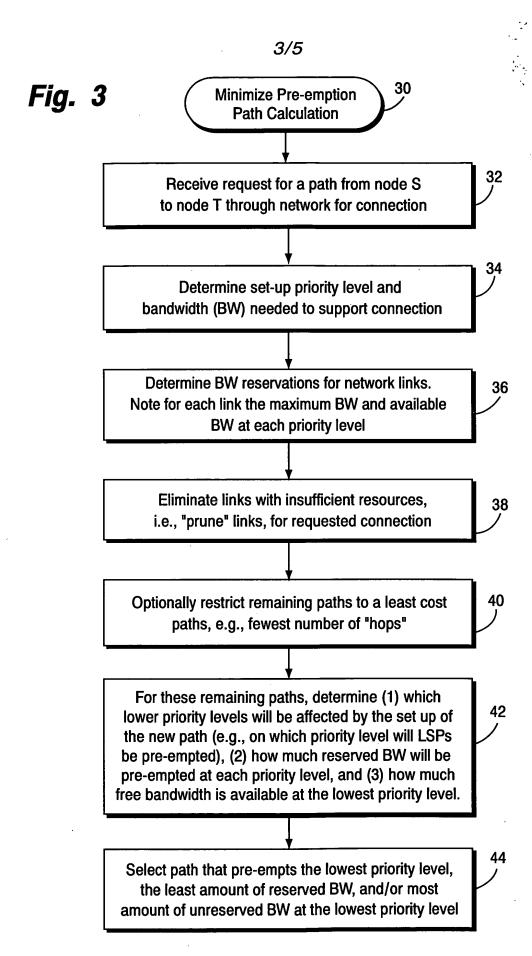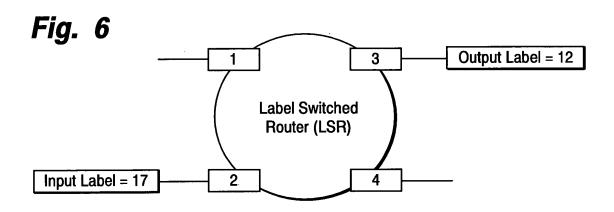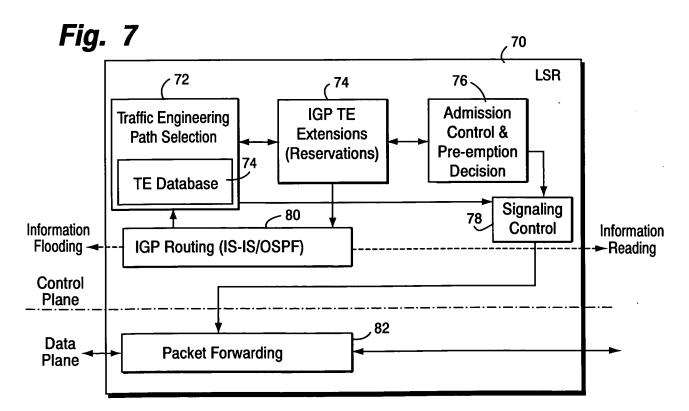| Input	Input Label	Output	Output Label
. . .	. . .	. . .	. . .
2	17	3	12
. . .	. . .	. . .	. . .

Fig. 6

Fig. 7

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Fig. 8

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                                                                    100
    ╭──────────────────────────────────────────────────────╮
   │          LSR Edge Router Pre-emption Strategies         │
    ╰──────────────────────────────────────────────────────╯
                              │
                              ▼                              102
   ┌──────────────────────────────────────────────────────┐
   │  From flooded link-state information in the TE database,│
   │       determine the highest priority level on which      │
   │      pre-emption must occur to establish the new LSP     │
   └──────────────────────────────────────────────────────┘
                              │
                              ▼                              104
   ┌──────────────────────────────────────────────────────┐
   │            Determine the BW that will be pre-empted       │
   │             by the new LSP at each priority level         │
   └──────────────────────────────────────────────────────┘
                              │
                              ▼                              106
   ┌──────────────────────────────────────────────────────┐
   │    Determine the total BW that will be pre-empted on     │
   │  all priority levels by the new LSP and the unreserved   │
   │   bandwidth at the lowest priority level for this link   │
   └──────────────────────────────────────────────────────┘
                              │
                              ▼                              108
```

┌──┐
Example Pre-emption Minimization Strategies
  • minimize affected priority levels along the path,
  • at the affected priority level, minimize affected bandwidth,
  • maximize unreserved bandwidth at the lowest priority level,
  • employ any combination of the above,
  • complement any of the above with one or more other strategies
    before or after pre-emption reduction, (e.g., first restrict path selection
    to least cost paths based on the original OSPF link cost as a link metric,
    then maximize free bandwidth, then minimize affected highest priority
    level, then minimize affected bandwidth at the affected levels, etc.)
└──┘